ISSN: 0974 - 7451

Volume 9 Issue 11



Environmental Science An Indian Journal

Critical Review

ESAIJ, 9(11), 2014 [397-404]

The role of rural areas as leverage for renewable energy development in Morocco: The case of sidi taïbi village

S.El Ahmadi¹, A.Echchelh^{2*}, A.Laaraifi, M.El Ganaoui³, A.Chaouch¹ ¹Laboratory of Applied Chemistry and Quality Control, (MOROCCO) ²Laboratory of Electrical Engineering and Energy System, Faculty of Science BP133, Ibn Tofail University Kentia, (MOROCCO) ³IUT Henri Poincaré de Longwy University Nancy, (MOROCCO) E-mail: echeladil@yahoo.fr

ABSTRACT

This study focuses on the assessment of Morocco's ability to exploit natural resources (sun, wind...etc.) for decentralized energy production. This decentralization will free rural areas from its power isolation. The aim of this study is also to demonstrate the role of the rural areas in leveraging the use and development of renewable energy also known as clean and alternative energy. The results and implications are based on the analysis and the treatment of data from a survey conducted in the rural town of Sidi Taïbi. In general, the high cost of equipment with limited funding resources for rural areas, the lack of information and lack of a structured market are the main limitations for renewable energies' development. Thus, this research leads to twofold sets of results that also aim to optimize the use of renewable © 2014 Trade Science Inc. - INDIA energies.

INTRODUCTION

In 2011, the net energy bill of Morocco increased to 79.9 billion MAD, a small part of it is renewable energy. Energy consumption has increased too from 10.46 Mtep in 2002 to 17.26 Mtep in 2011 which is an increase of 5.7% per year^[1].

At present, coal and oil remain the main energy sources in Morocco. The share of petroleum products in the energy balance is very crucial and amounts to 61.9%.

This energy, a highly generating source of CO2, is responsible for 27% of the country's greenhouse gas emissions which are of nearly 11 million tons of CO2

per year. (Source: French Global Environment Fund)^[2]. According to 2011 statistics from the Ministry of Energy and Mines, Moroccan emissions of CO2 were of 49.9 million tons.

Given the instability (in terms of price and availability) of fossil fuels, and the importance of energy in the modern economy, the diversification of energy sources and the lessening of the national dependence vis-a-vis the oil and gas resources is a major target for Morocco.

In nowadays, nearly 2 billion people (about one of three individuals), living mainly in rural areas, have no access to power^[2].

In Morocco, the rural population is still of a big size. A significant proportion of households are living in

KEYWORDS

Rural: Renewable energy; Photovoltaic; **Environment:** Decentralized energy; Sustainable development.

remote villages or in scattered settlements which makes rural electrification via the connection to the national electrical grid a complex task.

Reliable and less expensive technical solutions, for decentralized power generation, utilize natural resources (sun, wind, water, and biomass). A study in Senegal showed that decentralized photovoltaic technologies have competitive prices compared to the extension of the electrical grid to remote rural areas^[4]

Indeed, Morocco could exploit its natural resources to produce clean energy, given its proximity to Europe and the significant solar radiation (equivalent to the average in southern Europe)^[3]as it benefits from more than 3,000 hours per year of sunshine that constitutes about a 5 kWh/m2 per year of irradiation (Figure 1). In 2011 the solar potential only reached 5 kWh/m2/ d. ^[1] To this end, we will present first the results of the survey after presenting the followed methodology that is based on a quantitative method. The aim is to do an analysis, followed by a treatment of the collected data. Based on this analysis, we will identify the potential for renewable energy in rural areas.

THE STUDY SITE AND THE OBJECTIVES

According to the National Office of Electricity and Potable water ONEE^[1] in 2011, the rural electrification





rate reached 97.4%, compared to 72% in late 2004^[3]. The number of villages electrified according to PERG program is 37733 villages^[1]. Some villages are still not connected to the national grid because of the complexity of the connection, the dispersion of homes and their distance from the main electrical grid among other reasons that stand all as obstacles.

The village in our study is one of the cases where electrifications cannot easily be carried out. Sidi Taïbi is located northwest of Rabat city (24.8 Km away). The village is a point in case as it endeavors producing its own power through the use of renewable energy in the absence of electrical grid.

According to a census carried out by the regional office of the High Commission for Planning in 2004, the population of Sidi Taïbi amounted to 25,005 inhabitants and 4612 households. Only 13.2% of the population has electricity. The poverty rate in the village is of 20% of the population.

The population of Sidi Taïbi is a young population; most of their age ranges between 20 and 50 years. 56.05% of the surveyed population is men and 43.95% is women.

The majority of the inhabitants (95.06%) own their homes. According to the High Commission for Planning, 82% of the population lives in modern Moroccan houses.

The town of Sidi Taïbi is divided into three areas: AREA I: Benefits of the electrical grid.

AREA II: Uses renewable energy in parallel with the electrical grid as ONEE's power usually fails.

AREA III: Uses renewable energy especially solar energy.

Our objective is to:

1- Present the results of the survey to identify the limits and the benefits of renewable energy.

2- Establish an inventory of behaviors, attitudes and practices in a rural environment in regards to renewable energy. 3- Identify the potential of rural communities in regards to renewable energy use and how we can exploit and develop this potential.

Similar studies were conducted in several countries; In Tunisia a survey was conducted by the National Agency for Energy Efficiency (ANME),^[6]in close collaboration with the German Technical Cooperation Agency (GIZ), on the knowledge, perceptions and attitudes of Tunisians

Environmental Science An Indian Journal

towards energy efficiency. In France, four studies were conducted by the Environment and Energy Management Agency "ADEME"^[7] and another study is conducted by the regional observatory of energy and greenhouse gases emissions about energy consumption and household behavior of Poitou-Charentes in October 2008^[8].

METHODOLOGY

The survey was conducted by a team of master students at the Faculty of Ibn Tofail in Kenitra, with a random sample of 405 homes (primary residences) from 8 districts representing the entire town Sidi Taïbi. On average 50 households in each of the districts were interviewed. Door to door interviews were conducted with the inhabitants according to a pre-survey for a period of 15 days. Once the questionnaires completed by the investigators, the team conducted data processing with statistical software. An analysis of the results then was performed.

RESULTS

The socio economic situation of inhabitants

The average monthly income of the majority of households surveyed does not exceed 3000 MAD

Monthly income	number of households	Freq.
Less 1000 MAD	80	20,41%
1000 - 2000	166	42,35%
2100 - 2400	81	20,66%
2500 - 3000	57	14,54%
Over 3000 MAD	8	2,04%





(equivalent of \in 300). Only 2% of households have an income greater than 3000 MAD.

The average number of persons per household is 7 people, which raises the average of household size by 17% compared to 2004.

Residents interviewed work as laborers in neighboring cities (Salé, Kenitra...). Some work in crafts and agriculture. Others have developed their own business (cafe, grocery, nursery....). (Figure 2)

43.16% of the respondents received no education, 29.56% did not study beyond elementary level and 16.20% dropped out of school at the secondary level.

With the evolution of society and the new lifestyles, new needs emerged, namely in terms of comfort. This has impacted, often increased, the energy consumption. (Source regional observatory of energy and greenhouse gases emissions).

Source of energy and energy behaviour

Renewable energy is the main energy type of more than 60% of households in the village compared to 11% in 2004 (an increase of about 49%). The main renewable energy used is photovoltaic solar energy 99.59%. Figure3



Figure 3 : Distribution of Energy sources

The electrical grid of ONEE comes second with 37%, butane gas and candles represent only 2.50%. In 2004 butane gas and candles represented 90% of energy used which is a decrease of approximately 88%. 10.40% of households chose to mix between ONEE's electrical grid and renewable energy.

Almost all of the respondents spontaneously associated renewable energies with solar and wind power.

A pretty good range of energy-saving lamps is used. Almost 79% of households use LBC in their houses. Figure According to an article published in the Moroc-



can newspaper "L'économiste", energy-saving lamps enable the savings of around 80% of energy while obtaining the same level of lighting and they have a lifespan of up to 15 times of the incandescent lamps lifespan in addition to their improved safety thanks to their low heat that makes them environment friendly^[9]. All those who use low-energy bulbs are not aware of INARA* program proposed by ONEE. 99.70% of the respondents have never heard of it. Figure 5





Figure 5 : Percentage of households benefiting from the INARA program

The power essentially allows home lighting and connecting rural households to urban areas, through television, radio and cell phone. 77% of households have TV in colors, black and white TV 22%, gas refrigerator 0.54%, 0.27% power refrigerator and nobody reported to be equipped with a dishwasher or a vacuum cleaner.

Devices used for leisure and comfort are less common. All households do not own a washing machine or a microwave. Buying a power transformer is necessary to use other equipment like washing machine and flat screen TV which engenders additional costs.

Hindrances, levers and limitations of renewable

Environmental Science

An Indian Journal

energy

Hindrances

The main triggers for the use of solar photovoltaic energy is the unavailability of the electrical grid in the village as well as energy saving. No one seems to consider the environmental dimension of renewable energy. Some people are not willing to invest in renewable energy and do not wish in any way to change the ONEE electrical grid for another source of energy; the reason is that for the majority of households that do not use renewable energy, (20.50% of households), the cost of installation is a major obstacle. The total cost of equipment varies between 1000 and 6000 MAD (in average 3448.65 MAD). This price includes the price of the plate, the inverter and the battery. The cost depends on the strength of the photovoltaic panel (installed capacities range from 100 watts to 600 watts) and it also depends on the quality and brand of the battery. Some households invested in old equipment that is less expensive.

The lack of information is another obstacle. 3.73% of the respondents did not have enough information on neither clean energy nor its advantages. Failures are also considered another major stumbling block of renewable energies. The main failures are often due to problems with the regulator or battery. Frequent failures depend on the quality of the battery. Some batteries have a longer lifespan than others (Figure 5). They also depend on the know-how and the handling of equipment (i.e. if there is too much sun, the buttery charging should be paused).

The Limitations of renewable energy

People interviewed (58.85%) are dissatisfied with solar energy because of its limitations. The most cited during interviews limitations include:

- ✓ The light is low enough to well illuminate;
- \checkmark The panels do not work well in winter;
- ✓ The batteries run out quickly when there is not enough sun;
- ✓ The price of batteries is high and their lifespan is too short;
- ✓ The small panels, which the majority of people possess, do not power feed all the home appliances.
- ✓ Several appliances cannot be used at the same time,
- \checkmark Some appliances do not function in the absence of

the photovoltaic transformer.

The levers of renewable energy

The proportion of households satisfied with solar energy represents 41.15%. These households expressed their willingness of keeping their renewable energy equipment even after they are connected to ONEE's electrical grid. For this category, Solar energy has many advantages: it is more economical, replaces the lack of electricity in the village, it is less risky than the candles they were using before and there are no bills to pay at the end of each month.

Reasons that would likely encourage people to invest in renewable energy are shown in table below:

TABLE 2 : Incentives for the use of ENR

Incentives	Distribution in%
None	9%
Lower equipment prices	58%
Increase in the price of the currently used of the energy	3%
Sensitizing about the reliability and performance of renewable energy	11%
A state subsidy (Financial Assistance)	19%

If one day the village is connected to the ONEE electrical grid, the majority of the population (62.55%) will keep the renewable source since they have already invested in the equipment. However, 37.45% of households said they do not wish to keep the equipment used in generating energy from the sun as they rather to be connected to ONEE's electrical grid which provides power with more comfort.

The equipment maintenance

Periodic maintenance of the equipment is ensured by 77.39% of the respondents. 93.37% of the households who periodically maintain their equipment do it by themselves, 4.59% hire a technician and 1.02%





seeks the help of neighbors. Others use family members or friends. This maintenance consists of cleaning the plates, checking up the water level of the battery and monitoring the inverter and the controller. Maintenance intervals vary from 15 days to 1 year. (Figure 7)



Figure 7: Equipment maintenance frequency

SUMMARY OF THE RESULTS

Renewable energy, especially solar energy, is widespread in the rural village of Sidi Taïbi only due to the absence of any other source of energy. Citizens are still not aware of the importance of energy saving or the impact of fossil fuels on the environment.

More than 30% of households do not want to keep the photovoltaic panels mainly because of the high frequent maintenance and repair costs, especially batteries that have a short lifespan that does not exceed 2 years and their high price that ranges from 1000 MAD 3000 MAD.

Renewable energies have some limits of technical order: the functioning of solar panels depends on solar radiation which makes it in the winter time very limited. In the summer, panels work better but solar radiation must be monitored so as to avoid overcharging the battery that could be damaged otherwise along with lamps and any other electrical equipment connected to it.

Solar energy is perfect for lighting, but people are deprived of some technologies and equipment that are necessary for a better quality of life. These machines cannot function without a transformer that helps adapting the photovoltaic energy.

To use multiple home appliances, the power of the panels must be significant. Otherwise the panel will serve only one appliance.



"In a recent study in Kenya, Jacobson(2007) shows that the only "use" of economic power is linked to the pursuit of certain night activities such as accounting for small business or lessons' preparation by teachers. This is partly due to the low capacity of solar kits used locally and that does not allow the use of machines (husking mills etc.) Or even kitchen appliances or refrigeration. Similar observations are nevertheless common in villages with direct access to centralized electrical grid.^[8]

The socio-economic situation and the lack of financial support does not allow people to appropriate a system with a high capacity.

As there are no means of storing energy efficiently and with low costs, the fact that solar power can produce energy only the days when the weather is good and a wind turbine works only when there is enough wind, all significantly limit the potential of these two energy sources.

In order to meet the needs, a large part of the energy must be produced in tape, that is to say, in a stable and continuous way, which urges us to use more controllable energy sources... often fossil fuels or nuclear.

Obstacles to the development of renewable energy do not prevent renewable energy to develop. Some people have kept the same equipment used to generate renewable energies though they got connected to the local electrical grid and still use solar lighting. The energy mix will save energy and reduce electricity bills.

Some aid programs are initiated by the Moroccan State or organizations less known by the public, to mention an example the INARA program that was set up to help people benefit from low energy lamps for free.

Among the constraints to the development of renewable energy and energy efficiency is the lack of information and citizens' awareness; the absence of sensitization among citizens about the importance of energy saving, energy efficiency and climate change has a negative impact on their energy use behavior. The majority if not the whole population think they are not affected by climate change and are not willing to change their behavior to alleviate the damages. In addition, they are not ready to invest in photovoltaic or wind equipment because they feel they are unreliable and do not allow them to live properly; being connected however to the grid is more comfortable for them and their chil-

Environmental Science An Indian Journal

dren. The main events that may promote the development of renewable energy are of economic order, particularly the low prices of the equipment to be installed. An issue of technical reliability and need for the support, reinsurance and citizen awareness is very important. Citizens are willing to invest in renewable energy if the equipment's prices are lower because they are relatively high in the current socio-economic situation of citizens. The state can help people thrugh subsidies and associations may also intervene for the development of clean energy.

ESAIJ, 9(11) 2014

CONCLUSION

The main point to be drawn from this paper is that with a rational value, the renewable energy resources can be an important weapon for the fight against poverty, especially in rural areas, thus contributing to improving the quality of life and sustainable development. Rural areas may also contribute to the development of renewable energy (Figure 8)





Through the results of the survey, it can be demonstrated that energy isolation, where the rural world was long held in, is largely responsible for the underdevelopment of the country: low school enrollment rate, lack of health facilities and potable water. Today the rural areas can be a lever for the country through the development of renewable energies. Rural communities can become key players in new fields of activity that will take considerable importance in the coming years; the best resources of renewable energy are found in rural areas for the majority of energy systems. (Figure 9)

Decentralized rural electrification can help expand access to energy services for rural populations who are currently, and may be much later, totally private.

States can develop renewable energy starting from the rural areas before wide spreading in urban areas. Generally, in rural environments, it is difficult to connect





to local area networks. Sidi Taïbi is an illustration of such case as it was for a long time deprived of energy and was able to develop its own energy through photovoltaic kits. This experience could be even more successful if there had been an engagement of local communities and associations to help get more efficient equipment. experience of this village should be extended by the Moroccan State in other villages with the involvement of all economic actors.

Indeed, Morocco benefits from significant sun radiation throughout the year which allows for operating photovoltaic panels optimally. In addition, this decentralized system without any grid connection meets power needs of rural households (up to 10 times lower than urban areas). Finally, the cost of the system (taking into account public investment aid) and its operation is accessible for a rural household that spends 15-20% of their income on energy purchases. (Design: E. Rich / Odyssey June 2005)^[8]

It is acknowledged that the Moroccan State made considerable efforts for the development of renewable energy through large solar and wind projects and through programs such as the program of the market development for solar water heaters PROMASOL, the National Program for the Rational Use of Firewood and the Global Rural Electrification Program (PERG), which allowed the spread of decentralized rural electrification. Nevertheless, the efforts remains inadequate and organizations in this sector are defective which does not help reducing energy bills and make the country a producer and explorer of energy as there are still communities deprived from power in 2013.

Moreover, the energy policy is no longer effective and tenable without sensitizing and involving citizens in the use of ecological and competitive energy.

Rationalized consumption encourages the exploration and the development of local resources. While a stronger government action could steer a more sustainable energy path.

The development of renewable energies calls for the involvement and commitment of all stakeholders, academics, citizens, associations, consumers and local communities. Both the State and the citizen should be included in a global strategy that integrates three pillars: social, economic and natural.

The development and the involvement in renewable energies will increase notably by the adoption of favorable policies to the massive use of renewable energy. For instance: facilitating access to equipment, support for the private sector, etc.

The creation of a training cycle in universities and engineering schools can help the development of research related to the exploration of new technologies, support for and promotion of training and research in the field of energy. Also, encouraging Moroccan companies to engage in scientific and technological partnerships is necessary for the development of renewable energies. Integrating renewable energies into the curricula of science classes will provide more insights about the behavior of energy consumption and better ways of sensitizing Moroccan citizens about the importance of renewable energy and informing them on the operation of equipment through Energy Information Spaces (EIS).

REFERENCES

- [1] Ministry of Energy, Mining, Water and Environment Department of Energy and Mining. Energy key fact figures for Year, (2011).
- [2] French Global Environment Fund. Fight against the greenhouse effect and climate change: Decentralized rural electrification in Morocco in June, (2005).
- [3] http://www.masen.org.ma/?Id=15&lang=fr
- [4] Renewable Decentralized in Developing Countries:





Appraisal from Microgrids Project in Senegal (Djiby-Racine Thiam *) 2010 Elsevier Ltd. Renewable Energy, **35**, 1615-1623 (**2010**).

- [5] National Electricity Office. Annual Report, (2004).
- [6] Tunisia: Financing control for Hammamet (Tunisia), 2007 French evelopment Agency. Research Department, (2007).
- [7] French People and Renewable Energy. Results of the study conducted by Ipsos for the SER Jan, (2013).
- [8] Impact Analysis Series Ex Post No. 3 January 2010 "Studies of the impact of rural electrification programs in sub-Saharan Africa. Tanguy Bernard, Division of Evaluation and Capitalization, French Development Agency, (2010).
- [9] http://www.leconomistemaghrebin.com/2012/10/08/ enquete-sur-les-connaissances-perceptions-et-attitudes-des-tunisiens/ (Source: newspaper ECONO-MIST Edition N ° 3478 of 2011/03/03), (2008).

- [10] Regional Observatory for Energy and Greenhouse Gases emissions. Energy Consumption and on household behavior of Poitou-Charentes in the home in October 2008. New owners consulting marketing research, (2008).
- [11] Direct Foreign Investment opportunities in Morocco in the sectors of Energy, Mining and Environment. International Conference on Foreign Direct Investment and the Environment. The Organization of Economic Cooperation and Development - Paris, 07-08 February, (2002).
- [12] Internship Report / CDER (Center for Renewable Energy Development in Morocco) in November 2004 Manuel Antonio Leandro Reguillo.